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A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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degree of

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BY

JOHN H. BRANDT

Norman, Oklahoma

1973

THE EFFECTS ON MATHEMATICS ACHIEVEMENT OF THREE
DIFFERENT PRACTICE AMOUNTS WITH ELEMENTARY
CHILDREN IN SELECTED TITLE I SCHOOLS

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This study is dedicated to the boys and girls who contributed their energy and time, and to the teachers who volunteered to help on condition that this study contribute to their efforts to help children.

To all these children, teachers, and professors, my sincere and heartfelt thanks.

John H. Brandt

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CHAPTER I

INTRODUCTION

In view of today's rapid technical advancements and ever-expanding knowledge of the human being and the world he lives in, the methodologies to which children are exposed in schools are of increasing significance. The question of the appropriate amount of practice or drill persists in education today as in the past. Solutions to date are partial, compromising in nature, and certainly not unanimously accepted.

Mowrer has explained that man is a product of and, in fact, has two great heritages. One is biological, while the other is social. Biologically, one's inheritance is carried by and transmitted through the chromosomes one receives from his ancestors. On the other hand, the social inheritance is received from the so-called "culture" of the group. This social inheritance or culture is acquired through learning. Mowrer further points out that the capacity to learn is biologically provided, and then having delineated between biological and social influences, concludes by stating, "In this frame of reference, it is of no particular consequence what an organism learns: the basic question is how."[1]

Thorndike submitted his opinion as to the "how" of learning and he suggested that the teacher had two major problems or things to do. First, he had to arrange external conditions of presentation so that the stimulus and response had the proper timing. There needed to be contiguity between the presentation of the stimulus and the occurring of the response. Second, he had to insure that sufficient repetition occurred. Such repetition was necessary for two reasons. It would increase the strength of the learned connections (the more the repetition within limits the better the learning). Also, repetition was needed to insure remembering (the greater the number of repetitions, the better the retention).

In 1931 Thorndike expressed himself as to the resoning behind his theory.

> I conclude therefore that the general laws of human behavior which explain how a child learns to talk or dress himself and why he gets up in the morning and goes to bed at night also explains how he learns geometry or philosophy and why he succeeds or fails in the most abstruse problems, and that there exists no fundamental physiological contrast between fixed habits and reasoning.[2]

Since 1931, considerable effort has been spent to present evidence to support, reject, or to modify Thorndike's

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[1]O. Hobart Mowrer, Learning Theory and Behavior (New York: John Wiley and Sons, Inc., 1960), p. 8.

[2]E. L. Thorndike, Human Learning (New York: The Century Company, 1931), p. 160.

theory. Glaser, for instance, recently speculated that an instructional technology based upon an underlying science of learning may be emerging. In this case, he (Glaser) refers to instructional technology in much the same way one would refer to engineering or to medical technology. He indicates that the reason some people are asking or questioning what is being learned is so that the study of how it can be learned can be examined in view of the subject matter. He contends that the examination of psychology, individual-difference measurement, and experimental psychology can best be pursued by questioning the "what" that is being learned and then relating it to "how" it is being learned in terms of the subject matter.

More variables that influence the instructional process in schools are being examined. Then too, more questions are being raised as to the relevance and the appropriateness of the current evaluation processes. In view of these questions, Glaser contends learning theories will take on different requirements.

> In all probability, in contrast to their present form, they will be more amenable to the social and developmental differences between individuals; they will take on more cognitive, subject-matter-like tasks; and they will pay attention to the design of experimental tasks that optimize rather than only comparing conditions for learning.[1]

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[1]Robert Glaser, Encyclopedia of Educational Research, Vol. 1, p. 1484.

Frymier contends that, "Everything about the educational program must be subjected to empirical study in terms of what the school does to teach young people to grow up and to behave in democratic or authoritarian ways."[1]

Brameld points out that education is compelled to create new models of the curriculum. Maintaining that the entire conventional structure of subjects and subdivisions of knowledge have, for too long a time, reflected an outworn, overly glossy, atomistic model of both the universe and of man, Brameld demands that these conventional practices be subjected to experimental practice and repudiated or superceded.[2]

Engler agrees with Brameld and contends that the most accurate statement anyone can make about present methods of instruction is that they are old, and, therefore, subject to question and to scientific scrutiny. Despite the better training of our teachers of today, the relationship between teacher and learner remains basically the same. "Moreover, the process by means of which instruction is carried on has not changed in any fundamental respect during this period."[3]

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[1]Jack Frymier, "Authoritarianism and the Phenomena of Rebellion," Curriculum Decisions: Social Realities, A.S.C.D. Yearbook, Washington, D.C., 1968, p. 78.

[2]Theodore Brameld, "A Cross-Cutting Approach to the Curriculum," Phi Delta Kappan, March, 1970, p. 346.

[3]David Engler, "Instruction Technology and the Curriculum," Phi Delta Kappan, March, 1970, p. 379.

Beauchamp explained that the school had the dual responsibility of satisfying the interests and the needs of both children and society. In this dual role, the school will need to assume the responsibility of consistently performing in the best possible way. To do this, it becomes the responsibility of the school to seek out ways of improvement and incorporate them into the instructional effort so to improve the output of the school . . . the pupil.[1]

Statement of Problem

Whereas, there has been general agreement in the significance and importance of practice or drill, there remains a question pertaining to the amount of drill and the significance of that amount. To this end, this study addresses itself. It is recognized, that drill may be helpful to some children and worthless or questionable to others. However, there may be some generalizations regarding practice that will apply to most situations. More specifically, what are the effects upon achievement of varied practice amounts with elementary children in selected Title I schools?

Purpose of the Study

It shall be the purpose of this study to observe the effects on mathematics achievement of varying practice amounts on three groups of selected Title I elementary school children.

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[1]George A. Beauchamp, Basic Dimensions of Elementary Methods (Boston: Allyn and Bacon, Inc., 1959), p. 237.

Hypothesis

There is no difference in mathematics achievement of Title I children due to the effects of extensive drill (twenty-five drill items), limited drill (ten drill items), and no drill (zero drill items). The level of confidence will be .05.

Limitations

This study will concern itself only with learning after immediate practice. It will limit itself to third and fourth grade children and only to Title I schools. The experimental period will last six weeks.

Definition of Terms

Practice and/or Drill--These terms shall be used interchangeably and shall mean any extra items beyond the page upon which the concept is presented.

Significance

Whole generations of instructional materials and teacher procedures have been influenced in a variety of ways by application of Skinnerean conceptions of learning to the process of education. However, some studies have failed to find the evidence of the effectiveness of the Skinnerean concept of repetition for learning and remembering. These studies are concerned with the effects of repetition immediately after learning. This study will examine the effects of repetition under similar circumstances, but will not test the effect of repetition in the form of spaced reviews.

Fleming points out that, "It (learning) will come best from a rich, challenging environment, full of opportunities for reasoning, testing thought, trying out hypotheses."[1]

Bruner contends much work needs to be done in examining current "effective" practices and . . . carrying out the kinds of research that can give support and guidance to the general effort at improving teaching.[2]

This study will gather data that will point out implications for improving teaching methods and economizing teaching time. Using selected Title I designated schools lends added importance to the significance of this study, due to the necessity of improving the quality of education and opportunity of the children attending such schools.

Havighurst questioned traditional methods and wonders about their worth in light of today's needs.

> At present, much of modern society half-heartedly obeys traditional moral principles which people are afraid or hesitant about analyzing because they are certain the old principles cannot stand contemporary scrutiny. Thus, modern man bows to necessity, economic and political. Some scholars question everything about the educational program and demand it be submitted to empirical scrutiny in terms of what the school does to teach young people.[3]

This study will attempt to submit to empirical testing an experimental effort aimed at improving instruction.

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[1] Robert S. Fleming, ed., Curriculum for Today's Boys and Girls (Columbus, Ohio: Charles E. Merrill Books, Inc., 1963), p. 43.

[2] Robert Havighurst, Human Development and Education (New York: 1953), p. 78.

[3] Ibid., p. 78.

Whereas, this study could be considered to be still within the framework of Havighurst's "old" methods, it is submitted that the improvement of instruction would be a significant effort to improve the public schools' product. Questioning is needed and desired, for through it comes answers which often become fresh and innovative. Empirical testing of methods will permit those methods to persist or perish.

Preferably, improvement and restructuring of questioned methods will become a cycle of continuous efforts toward making the good better and the not-so-good avoided and rejected.

Summing up, this study will measure achievement test scores of elementary children before and after a six-week period, in which time these children will have been exposed to varying amounts of drill. The results will provide evidence to improve methods of instruction in Title I schools and, perhaps, in other schools as well.

CHAPTER II

THEORETICAL FRAMEWORK AND RELATED LITERATURE

Ever since education became formalized in schools, teachers have been aware that learning in school is often not systematic. Material to be learned may be presented to students innumerable times without noticeable results.

There are three conceptions of the learning process which emerged prior to the 20th Century but continue to have influence in today's schools. They are: (1) mental discipline, (2) natural unfoldment, and (3) apperception. These three theories have one characteristic in common: all were developed as non-experimental psychologies of learning. That is, their basic orientation is philosophical or speculative.

More recently two contemporary types of learning theory have made extensive use of experimental evidence. These are the mechanistic stimulus-response associationisms, and the non-mechanistic Gestalt field theories. According to the doctrine of mental discipline, education is a process of discipline or training minds. It is a belief that in this process mental faculties are strengthened through exercise. Choice of learning materials is secondary to the nature of minds which supposedly undergo the disciplinary process.

In the early 1900's Thorndike and Woodsworth, in an example of empirical psychology, performed experiments at Columbia University to test the validity of mental discipline as a psychology of learning. Their basic conclusion was that the idea of mental discipline was and is scientifically untenable. Their experiments showed that drill or training in performing certain tasks did not strengthen the "so-called" faculties for performing such tasks. Further, Thorndike noticed that the results of this experimentation tended to show that the amount of general improvement--mental discipline--is small. Thus the values of subjects must be decided largely by the special learnings which they produced.

Learning through unfoldment relates to the nature of learning systems logically from the theory that man is naturally good and at the same time active in relation to his evvironment. The over-all philosophical framework of the natural-unfoldment position often is labeled romantic naturalism. Early development of this view was associated with Rousseau. His position was that everything in nature is basically good. Since man's hereditary nature is good, it need only be permitted to develop in a natural environment free from corruption. A child grows by unfolding that which nature has "biologically" placed within him, thereby placing emphasis on the study of learning. Learning is equated with maturation; "it just happens naturally."

Apperception is a process of association of new ideas with old ones. In contrast to mental discipline and natural unfoldment, it is a dynamic mental associationism based upon the presence that there are no innate ideas; everything a person knows comes to him from outside himself. Mind, then, is wholly a matter of content, a compound of elemental impressions bound together by association, and it is formed when subject matter is presented from without and makes certain associations or connections with prior contact.

Scientific learning theories fall into two major categories: associationisms and field or cognitive theories. Before the 20th Century had been under way long, a new form of associationism had become popular. This was a nonmentalistic or physiological associationism. Its chief exponents during the first half of the century were John B. Watson (1878-1958) and Edward L. Thorndike (1874-1949). Watson's psychology was known as behaviorism. Thorndike's was called connectionism, but it, too, in the broadest sense of the word, was "behavioristic." The psychological theories supported by these persons may be identified as stimulus-response associationisms. Neobehaviorists in education tend not to adhere rigidly to any one of the S-R patterns but intermix them in applying psychology to teaching procedures. Gutherie's conditioning has the stimuli and the response occurring simultaneously. This does not mean that repetition has no place in learning, but that within repetition there is an increasing number of stimuli made in conditioners; there is no strengthening of individual connections, but there is enlistment of more (connections).[1] Gutherie reasons that since association can occur with one connection and last for life, there is no need for anything like reward, pleasure, or "need reduction" to explain learning.

Hull's learning theory also is stimulus-response conditioning, but of a special kind, reinforcement. Within Hullian reinforcement, the stimulus precedes the response. Learning does not take place with a single trial; it is stamped in through a process of repeated need or drive stimulus reductions. Learning occurs through biological adaptation of an organism to its environment in a way to promote survival.

Skinner's operant conditioning neither precedes or occurs simultaneously with the response but following the response. The subject must first make the desired response and then a reward is provided. The reward makes it more likely that the correct response will occur. The essence of learning is not stimulus substitution but response modification. In learning there is a feedback from the reinforcing stimulus to the previous response. Emphasis, then, is on reinforcing agents, not on original causitive factors.

The second major family of contemporary learning theories originated in Germany. In 1912 a German psychologist

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[1]Morris L. Bigge and Maurice P. Hunt, Psychological Foundations of Education (New York: Harper & Row, 1962), p. 293.

philosopher, Max Wertheimer, presented a body of theory which came to be known as Gestalt psychology. Various other persons who had been thinking along the same lines contributed to this new school of thought. As Gestalt psychology evolved, other names such as field, phenomenological, and organismic psychology became associated with it. This study will refer to related theories which originated from Gestalt psychology as Gestalt field or cognitive field psychology. Gestalt field psychology was introduced into the U.S. in the 1920's. Gestalt-field psychology has gathered a large number of exponents and now can be considered the leading rival of S-R associationism. Lorenz stated it this way:

> Unless one understands the elements of a complete system as a whole, one cannot understand them at all. The more complex the structure of a system is, the greater this difficulty becomes, and it must be surmounted both in one's teaching and in one's research.[1]

The key work of Gestalt-field psychologists in describing learning is insight. They regard learning as a process of developing new insights or modifying old ones. Gestalt-field psychologists view learning as a purposive, explorative, imaginative, creative enterprise. This conception breaks completely with the idea that learning consists of linking one thing to another according to certain principles of association. Instead, the learning process is linked with thought

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[1]Konrad Lorenz, On Aggression (New York: Harcourt, Brace, and World, Inc., 1966), p. 10.

or conceptualization; it is a nonmechanistical development or change of insight.

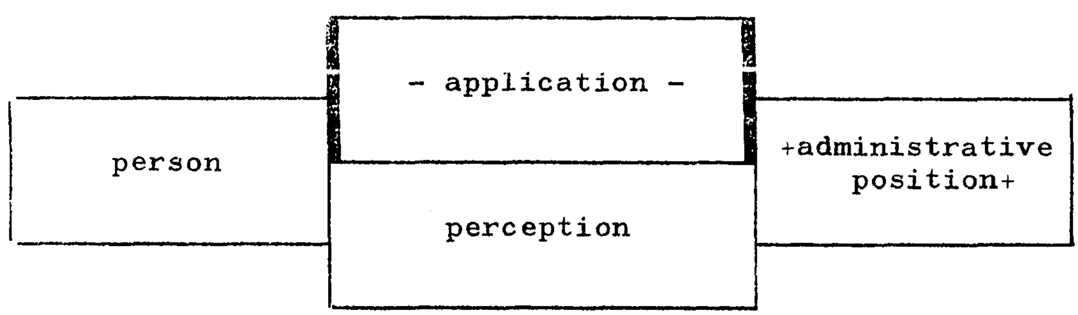
The cognitive-field psychology is attributed largely to Kurt Lewin and his associates. Lewin (1890-1947) considered psychology a science closely related to everyday life. The center of Lewin's psychological interest was in motivating conditions of person-environment situations. Whereas S-R associationists study psychology as a series of events, the very term field or field psychology implies that, psychologically interpreted, behavior has a unique meaning; it is described in terms of what exists for the person being studied. Lewin thought that objectivity in psychology demanded representing the field adequately and accurately as it exists for an individual at a particular time. Consequently, to be objective in psychology one must observe situations as the person being studied views them.

Lewin was convinced that in order to understand and predict behavior, one must consider a person and his environment a pattern of interdependent facts or functions. Thus instead of placing emphasis on a mathematical average of as many different cases as possible, he centered attention on careful, complete descriptions of particular persons' environmental situations. He indicated that it would be possible to construct as many life spaces as there are people and situations at any given time. A life space or field consists of the content of an individual's perception. Lewin's formula for his life space is B = f(P,E). Behavior (B) is the function (f) of psychological person (P) and psychological environment (E). A psychological person, so formulated, constitutes a life space. The life space then is a dynamic whole of such a nature that a change in any part affects other parts, and every change depends upon the whole; it is a totality of coexisting facts. Lewin defines the life space thusly:

> The totality of facts which determine the behavior of a given individual at a given time is the life space. It is represented as a two dimensional space in which the individual moves. This space contains the person himself, his goals, his "negative" goals (he is trying to avoid, barriers to free movement) and the paths he must follow to get what he wants. Life space is not the world of physical objects and other people, but the world as it affects the individual.[1]

Figure 1 represents a hypothetical life space of an individual. In this case the person is a classroom teacher desiring an administrative position.

FIGURE 1

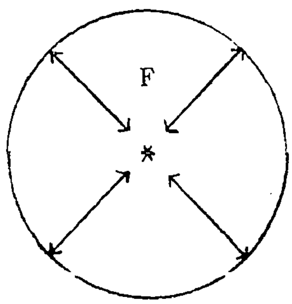


[1]Winfred F. Hill, Learning: A Survey of Psychological Interpretations (San Francisco: Chandler Publishing Co., 1963), p. 106.

The life space includes the person himself, his goals, and everything in his behavioral environment that influences his behavior. Note the heavy line or barrier between the person, his perception of the job, and the goal itself. The goal, in this case, is represented as a positive valance depicting desire for the position. But, the actual application for the position has a negative sign or valance, showing the person's efforts to avoid this area, therefore a goal being avoided. The teacher perceives the position as inaccessible and refuses to apply himself. Therefore, the goal will be difficult at best to achieve.

Figure 2 further explains life space.

FIGURE 2



* = any phenomenon   F = the field or structural systems within which the phenomenon occurs.

The asterix stands for the happening, thing, or quality whose "nature" is governed more by its relations to the definite circumscribed field that contains it than by any intrinsic or inherent forces. The double-headed arrows indicate that interdependence or reciprocal influence obtained between all parts of the whole and the total itself. Actually, the forces emanating from the whole are far more powerful and decisive than those coming from any of its segments. Advocates of field theory in educational psychology maintain that the three-fold task of any special science, the understanding, prediction, and control of events, is greatly facilitated by the use of the scheme here before sketched.[1]

Cognitive-field theory as other theories involves the kind of generalizations about learning which may be applied to actual persons in school situations. It is associated with the knowing and understanding functions which give meaning to a situation. It is built around the purpose underlying behavior, and persons' means and processes of understanding themselves as they function in relation to their goals. Factors of a life-space acquire meaning as a person formulates his goals and develops insights into ways of achieving them. Gestaltists feel that if a teacher is to help students make the most effective use of practice, then he must remember important principles concerning its use. Practice, to be effective, must be experimental; that is, accomplished by a questioning attitude. This will support the notion that the role of practice is not to strengthen neural connections but to contribute to the development or an insight.

Wertheimer declared that the important thing about solving problems was the insight by which the new problem was

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[1]Nelson B. Henry, ed., Psychology of Learning, 41st Yearbook of National Society of the Study of Education, Part II (Chicago: University of Chicago Press, 1942), p. 166.

restructured. In other words, a new and better Gestalt was formed. "Understanding implies not merely logical correctness, but perception of the problem as an integrated whole, of the ways in which the means lead to the end."[1] Much of the emphasis in Gestalt interpretations of learning is on finding new ways to reach goals when the old ways are blocked.

Bigge says, "the new ways involve finding detours around barriers, either in physical space or in Lewin's topological life space."[2] Gestaltists interpret such a detour solution as involving a restructuring of the life space, a realization that it is possible to get around the barrier.

Bigge continues,

> A child's behavior, to a very large degree, depends upon the cognitive structure of his life space. Learning results in building psychological traces which contribute to the structure and dynamics of future life spaces and thus effect future performance. According to cognitive-field psychology, a child in a learning situation is not unfolding according to nature; neither is he being passively conditioned always to respond in a desired manner. Rather, at his level of maturity and comprehension, he is differentiating and restructuring himself and his environment.[3]

The child then, is gaining or changing his insights. Developing personalities, attitudes and ideas involving emotional and imaginative functions, Bigge implies, are as

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[1] Morris L. Bigge, Learning Theories for Teachers (New York: Harper and Row, 1964), p. 214.

[2] Ibid.

[3] Ibid., pp. 222-224.

necessary in factual math, science, and historical pursuits, as in the fine arts. By defining learning as essentially a "process," we should use inventive situations psychologically as well as mechanically.

Bair and Woodward suggest,

> Emphasis has shifted from rote memory work and the retention of factual knowledge to the processes involved in becoming educated. Thus, attention is now being given to teaching pupils how to learn rather than teaching them specific and often unrelated facts.[1]

They emphasize then, the cognitive approach to instruction.

Taba[2] points out the difference between the conflicting theories by indicating that practice consists of modifying each successive attempt to learn something, not repeating exactly the same act. Taba places herself in the cognitive-field theory group by her proposal that learning is more likely to be retained if it (learning) is internally motivated.

Generally, the subject of change is broad in scope and vague in direction. Change, to be sure, will occur, but what kind, and how, are thought-provoking questions that demand investigation. More specifically, this study will attempt to focus on learning, if any, that practice, or drill, will bring when applied to three groups of elementary, Title I, children in varying amounts over a six week period.

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[1]Medill Bair, and Richard G. Woodward, Team Teaching in Action (Boston: Houghton Mifflin Co., 1964), p. 8.

[2]Hilda Taba, Curriculum Development: Theory and Practice (New York: Harcourt, Brace, and World, Inc., 1968), p. 82.

Related Literature

Ausubel states his opinion in this manner.

> In terms of historical significance, therefore, theoretical importance, and relevance for current educational practice, few issues in educational psychology are more crucial than the role of frequency (of drill) in learning and retention.[1]

He thus draws attention to the importance and significance of the study of drill or practice.

In a recent article, Gagne' explored what he termed the direction in which learning theory is headed. He asked questions concerning repetition. In his opinion,

> There seems to be . . . some (lack) of evidence that simply practicing or repeating things after they have been learned has the effect of improving retention.[2]

The question then appears to be, is repetition a requisite for learning?

Rock investigated the role of repetition in 1957 and the major finding of interest is that in learning verbal paired associates, practice does not increase the strength of each learned item, but an item once learned is fully learned.[3]

Gagne' points out:

> If one wants to insure that a student can learn some specific new activity, the very best guarantee

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[1]David P. Ausubel, Educational Psychology: A Cognitive View (New York: Holt, Rinehart and Winston, Inc., 1968), p. 275.

[2]Robert H. Gagne', "Some Views of Learning and Instruction," Phi Delta Kappan, May, 1970, p. 471.

[3]I. Rock, "The Role of Repetition in Associate Learning," American Journal of Psychology, June, 1957, pp. 186-193.

> is to be sure he has previously learned the prerequisite capabilities. When this, in fact, has been accomplished, it seems to me quite likely that he will learn the new skills without repetition.[1]

Gagne', then, indicates the necessity of readiness for the learning of a new concept.

Gibson experimented with a variety of practice attempts. She formed three groups of third and fourth year students. One group had ten practice examples for each subordinate skill in an arithmetic experiment. A second group had twenty-five practice examples and the third group had no examples. The result was no significant difference in performance or in remembering, regardless of the amount of practice and repetition.[2]

Gibson's study had only ninety children on three I.Q. levels. All the children were instructed in subordinate skills. Subskill tests were administered following instructions. Children who met the learning criteria on the sub-skill tests were given an unrelated pleasant task to prevent rehearsal. The others were reinstructed.

Kimble and Shatel investigated the effects of drill as compared with no repetition and concluded, "With simpler skills, there is evidence that relatively massed practice leads to slower learning."[3]

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[1] Op. Cit., Phi Delta Kappan, 1970, p. 470.

[2] J. R. Gibson, "Transfer Effects of Practice Variety in Principle Learning" (unpublished Ph.D. dissertation, University of California, 1969).

[3] Gregory A. Kimble and Robert B. Shatel, "The Relationship between Two Kinds of Inhibition and the Amount of Practice," Journal of Experimental Psychology, Vol. 44, 1952, p. 355.

Banks talked about understanding and its relation to drill. He explained that ideally understanding should precede drill or practice, but that both are needed for skill development.

> . . . neither occurs as a result of the other, no amount of skill can insure understanding, and understanding does not eliminate the need for drill to establish the skill.[1]

Both practice and readiness are necessary for securing the skill.

Ryans thinks that the transmission of information through the teacher is often hampered by various conditions. In at least one respect, he echoes Gagnes' concern about readiness or preparation. Ryans says, "Some of the conditions are inadequate establishment in the student for the state of readiness necessary for receiving the information upon which the lesson is focused . . . "[2]

Stroud suggests concerning ourselves with concept learning only after immediate practice and the investigation of this effect on achievement test scores.

> Undoubtedly, there are many undesirable features of drill work in our schools . . . Because of its repetitive character, pupils are likely to lose interest in it more quickly than in most other kinds

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[1] J. Houston Banks, Learning and Teaching Arithmetic (New York: Allen and Bacon, Inc., 1959), p. 11.

[2] David G. Ryans, "A Model of Instruction Based on Information Systems Concepts," Theories of Instruction, A.S.C.D. Yearbook, Washington, D.C., 1965, p. 38.

> of activity. For this reason, the length of such practice periods should be relatively short.[1]

This chapter has briefly explained two major psychological schools, their views on learning and how practice pertains to that learning. The chapter has also summarized some research previously done in practice and/or drill. Each psychological school views practice with importance but vary considerably in the way practice is used, and the concentration of that practice.

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[1] J. B. Stroud, "The Role of Practice in Learning," The Psychology of Learning, 41st Yearbook, National Society for the Study of Education, Part II (Chicago: Chicago University Press, 1942), p. 353.

CHAPTER III

DESIGN AND METHODOLOGY

Sample Selection

The present study will present evidence of the observed effects varying amounts of drill in arithmetic have on three groups of third and fourth year primary children. Primary children were selected for this study due to their more rapidly developing intellects.[1] There were eight elementary schools with large (30 percent) percentages of two or more racial minorities in the Oklahoma City Public School System. Three of these schools were inner-city schools and these three were used for the study. Twelve classrooms of third and fourth year children with approximately twenty-five children in each room comprised the sample; therefore, the total sample size was 250. The unit of analysis was the classroom.

The three exemplary public schools in Oklahoma City were selected for these reasons:

1. All three schools are designated Title I schools.
2. They all have high percentages of ethnic groups.
3. They are, as stated before, "inner-city" schools.

The schools are also racially desegregated in staff, as well

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[1]Benjamin S. Bloom, Introduction to Stability and Change in Human Characteristics (New York: John Wiley and Sons, 1964), p. 78.

as pupil populations. At one school, pupil population is 6 percent Negroid, 34 percent American Indian, and 60 percent Caucasian. The staff is 19 percent Negroid, 5 percent American Indian, and 76 percent Caucasian. The other two schools have similar staff and pupil populations.

Inasmuch as these classrooms represented three inner city schools, this study suggested generalizations for other classes and schools in similar conditions. The twelve rooms were randomly assigned intact to a control group or to one of two experimental groups. The control group of four classrooms had no drill on each concept immediately after presentation. One experimental group of four classrooms had ten extra practice or drill items in addition to the presentation, and the other experimental group, of four classrooms, had twenty-five extra practice items immediately following the presentation of the lesson. All groups used the same basic mathematics text for instruction and drill items for the experimental groups were taken from those suggested in the text. The purpose here being to test the null-hypothesis that:

> There is no difference in mathematics achievement of Title I children due to the effects of extensive drill (twenty-five drill items), limited drill (ten drill items), and no drill (zero drill items).

Treatment

The focus of the treatment groups was on one aspect of drill in arithmetic, that is, if immediate drill on a concept presented in class achieves a significant improvement on achievement test scores as compared to the control group. All three groups received instruction for the same time period, six weeks. Only arithmetic skills were used during this experiment on drill reinforcement. Skills developed during this time were multiplication and division. Addition and subtraction were reviewed but these skills were introduced earlier and retaught during the experimental time. Some geometrical and measurement skills were also introduced.

The present study will not relegate children to prerequisite achievement levels or attempt to bring all children to a pre-test standard. Each teacher was responsible for administration of the achievement tests and assignment of drill problems to the class. All problems were assigned on an individual basis to the children in the drill groups. All drill problems were from the same basic text as were the concepts. The control group was presented the concept but no drill.

Instrumentation

The instrument used in the collection of achievement test scores for all students was the Metropolitan Achievement Test, Form A, Elementary Battery, Arithmetic Section (see Appendix A). Form A was administered two times, once as a pre-test and once as a post-test by the classroom teacher. For the Metropolitan series every effort was made to obtain dependable interpretive or normative information, accurately representative for the achievement of pupils throughout the nation.[1] The Metropolitan Achievement Tests have been administered by the Oklahoma City Public School System for several years to the third and/or fourth year children in the elementary schools. The norms thus derived over these many years compare favorably with the national norms achieved by the testing company, Harcourt, Brace, and Jovanovich, Inc.

Validity.--The Metropolitan test norms describe the achievement of pupils "representative" of the nation's school population. The U.S. Office of Education, census, and other data describing the national population were used to establish specifications for the norm group. Normal age-grade placement was considered to be defined by the modal eighteen month range of ages in each grade--i.e., the eighteen month range including the greatest percent of pupils in the grade.[2]

Reliability.--The publisher's data reveals that the reliability co-efficient range for the arithmetic section of the Metropolitan was 0.91 to 0.93 with a median of 0.92. The standard error of measurement was a range of 1.8 to 2.3 with a median of 1.9. Reliability of the instrument used in this study was determined by the Kuder Richardson Formula for Reliability method and will be reported in Chapter IV.

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[1]Walter N. Durost, ed., Metropolitan Achievement Tests (New York: Harcourt, Brace and World, Inc., 1959), p. 19.

[2]Ibid., p. 20.

Method of Analysis

Ferguson suggested that the statistical method, analysis of co-variance (ANACOVA) is primarily used in education for its statistical control of an uncontrolled variable.[1] Therefore, analysis of co-variance for the statistical testing of the collected data will be used. Stanley and Campbell support Ferguson's reasoning:

> The analysis of co-variance with pre-test scores as the co-variate are usually preferable to simple gain scores comparisons. Since the great bulk of educational experiments show no significant differences and hence are frequently not reported, the use of this more precise analysis would seem highly desirable. Considering the labor of conducting an experiment, the labor of doing the proper analysis is relatively trivial.[2]

The analysis of co-variance may be used when the differing comparison groups cannot be equalized initially by matching students between groups. The ANACOVA process is to equate the groups statistically on one or more co-variates, which in this case is the pretest achievement scores of students in the three groups.

When intact classes have been randomly assigned to treatments, the randomization procedure obviously has employed fewer chance events. Lindquist provides a formula for a correct analysis. Essentially, the group means are used as the

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[1] George A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Company, 1966), p. 326.

[2] Donald T. Campbell and Julian C. Stanley, Handbook of Research on Teaching, ed. by N. L. Gage (Chicago: Rand-McNally and Co., 1963), p. 182.

basic observations, and treatment effects are tested against variations in these means. A co-variance analysis would use pretest means as the co-variate.[1]

The design is one in which equivalent groups achieved by randomization are employed. The design takes this form.

R O_1	X_1	O_2
R O_3	X_2	O_4
R O_5		O_6

The symbol R represents randomization of assignment (classroom). The O represents the groups tested (pre and post). The X represents the experimental variable (drill).[2]

Data Collection

All Metropolitan Achievement Test scores were obtained by the classroom teachers administering the tests to their own students. Pretests were given during the week of October, 1972, and posttests were administered in December, 1972. The researcher scored each test after receiving them from the teachers, which reduced any bias of teachers altering scores. Raw scores only were used for making statistical analyses.

Limitations

This study assumes that uncontrolled variables such as intelligence, race, sex, and home conditions were randomly

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[1]Donald T. Campbell and Julian C. Stanley, Handbook of Research on Teaching, ed. by N. L. Gage (Chicago: Rand-McNally and Company, 1963), p. 183.

[2]Ibid., p. 183.

distributed across all groups. This assumption is based upon the similarity of pupil populations of the three schools and the method used for class assignments to drill groups. It was also assumed that all students had met the necessary requirements of "readiness" for the text material assigned in all groups, i.e., the members of students in the groups who could not achieve at expected levels were about equal. These assumptions are limitations to internal validity of the present study and could possibly affect statistical outcomes. All classes were located in three Title I designated schools. It is assumed the effects of pupils leaving and arriving will be randomly distributed in all classes, since all the schools concerned consistently have large transient rates and large numbers of transfers.

CHAPTER IV

RESULTS, ANALYSIS AND DISCUSSION

This chapter presents the tabulated results of the statistical treatment of data obtained from the testing of the children in the twelve classrooms involved. The data gathered were used to test the null hypothesis.

> There is no difference in mathematics achievement test scores of Title I children due to the effects of extensive drill (25 drill tiems), limited drill (10 drill items), and no drill (zero drill items).

Data was collected by using the arithmetic computation section of the Metropolitan Achievement Test. This was used in third and fourth year classrooms in three schools in the Oklahoma City Public School System. Schools were selected on the basis of having a Title I designation and a representation of at least three races in the student population.

Results and Findings

The reliability of the pre and post tests were determined by the Kuder-Richardson twenty-one formula for a reliability estimate. The results indicated a reliability coefficient of .82 for the pre test and .78 for the post test, both of which were considered adequate for the study.

Homogeneity of Variance

Data obtained was submitted to an analysis of co-variance statistical test, which includes as one of its assumptions, homogeneity of variance. Testing for this assumption was done by the F Max test which compares the largest cell variance to the smallest cell variance.[1] The obtained F ratio was less than unity, indicating homogeneity of variance.

Homogeneity of Regression

Homogeneity of regression lines is another assumption for the analysis of co-variance. Manipulation of the data for testing this assumption included drawing regression lines, computing their coefficients, and finally computing to determine the homogeneity of the regression lines.

Figure 3 shows the regression line of the group means. This line is used in predicting a criterion group (post test) mean from a co-variate group (pre test) mean. The three points marked M_0, M_{10}, M_{25} refer to the three drill groups used in the study. The slant of the line indicates an overall increase in the post test means. This line is the best fitting line for the three means indicated.

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[1]George A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Company, 1966).

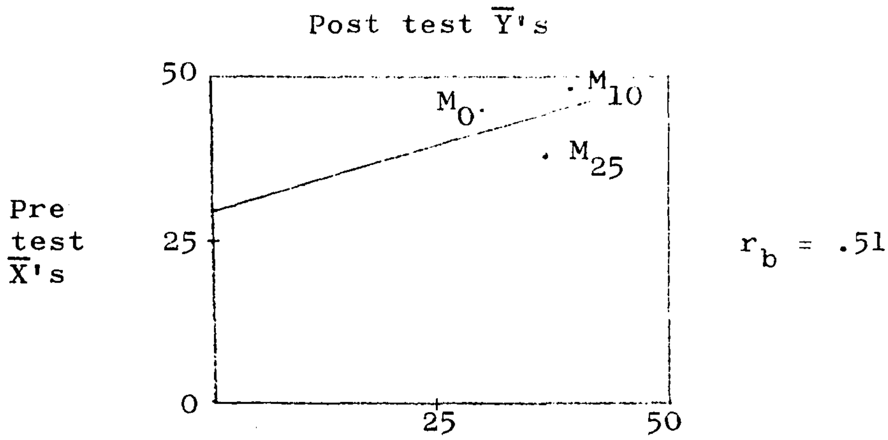

FIGURE 3.--Overall regression line for predicting post test scores from pre test scores.

The symbol r_b = .51 is the correlation of this line in prediction of post test scores from pre test scores.

Figure 4 shows the three regression lines for the three within group means. These lines are used to predict post test scores from pre test scores within each of the three groups.

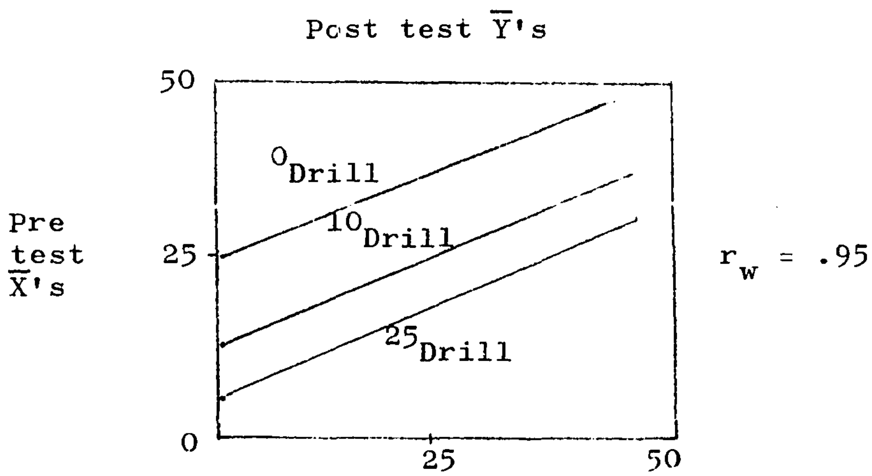

FIGURE 4.--Regression lines for within group means.

The symbol r_w = .95 is the correlation of this line in prediction of within group post test scores from within group pre test scores.

Figure 5 shows the overall total regression line. This line is used in predicting post test scores from pre test scores irrespective of the drill variable and based on all the observations combined.

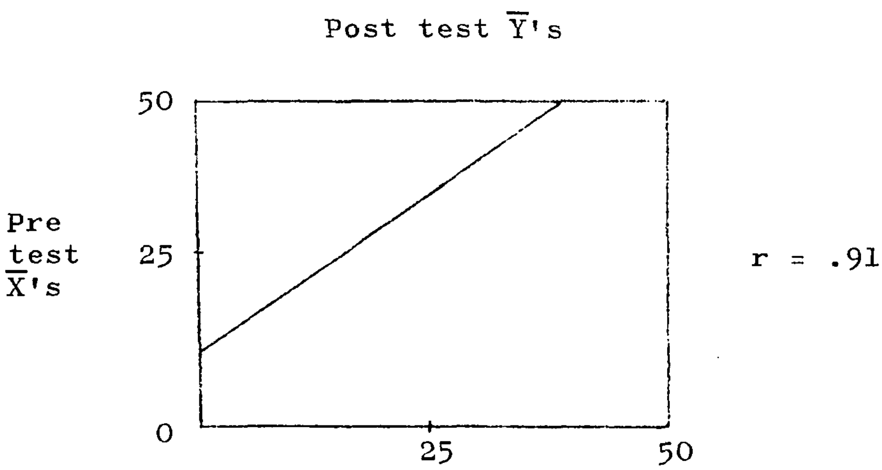

FIGURE 5.--Overall regression line.

Ferguson[1] suggests that after regression lines and correlations have been computed that the test for homogeneity of regression be calculated. The F ratio was calculated and found to be nonsignificant. This indicates the co-variant had a comparable effect on each group. Preliminary testing indicated assumptions of homogeneity of variance and regression lines were satisfied.

Major Findings

Table 1 is a comparison of the pre test and post test means and the standard deviations.

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[1]George A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Co., 1966), p. 338.

TABLE 1

A COMPARISON OF PRE TEST, POST TEST MEANS AND STANDARD DEVIATIONS

	0 Drill	10 Drill	25 Drill
Pre Test Means	18.336	22.950	21.321
Standard Deviations	3.57	6.89	8.69
Post Test Means	25.239	26.710	24.599
Standard Deviations	2.04	2.09	10.81

Table 1 indicates a general increase in all drill groups in post testing over pre testing.

Table 2 shows post test comparisons of the three drill groups by mean scores, adjusted mean scores, variances, and standard deviations.

TABLE 2

POST TEST MEANS, ADJUSTED MEANS, VARIANCES, AND STANDARD DEVIATIONS BY DRILL GROUPS

	0 Drill	10 Drill	25 Drill
Means	25.239	26.710	24.599
Adjusted Means	28.195	24.281	24.072
Variances	48.484	43.741	116.528
Standard Deviations	6.96	6.61	10.80

Table 3 shows the summary table and final tabulation of the data obtained. The form is that described by Winer.[1] The main effect, number of drill items, was tested co-variantly. The value of the adjusted F ratio was 2.09 which was nonsignificant at the .05 level. The null hypothesis was not rejected.

TABLE 3

SUMMARY TABLE, ANALYSIS OF VARIANCE AND ANALYSIS OF CO-VARIANCE

Source	Sum of Square	d/f	Variance Estimates
ANOVA with Pre-Test			
Treatments	43.814	2	21.907
Error	404.473	9	44.941
Total	448.287	11	F = <1*
ANOVA with Post-Test			
Treatments	9.370	2	4.685
Error	626.258	9	69.584
Total	635.628	11	F = <1*
ANOCOVA with Adjusted Post-Test Summary			
Treatments (reduced)	39.425	2	19.712
Error	75.456	8	9.432
Total	114.881	10	F = 2.09*

*Nonsignificant

Analysis of variance was used on pre test scores to check on the equality of the groups before treatment. They

[1] B. J. Winer, Statistical Principles in Experimental Design (New York: McGraw-Hill Book Co., 1962), p. 584.

were found to be nonsignificant in their variance. Post test scores were analyzed to determine if any drill group gained significantly before mean scores were statistically adjusted. Both pre and post test statistical treatments indicated nonsignificant variations in the scores obtained. That the pre test scores were not significantly different indicates relative similarity of the three groups with regard to arithmetic achievement. The lack of significance in post test scores indicates that drill in and of itself is not of sufficient strength to show significant gain scores under the conditions outlined in this study. Adjusted treatments as indicated earlier, showed overall nonsignificance.

All groups showed gains but not of a significant degree. Although nonsignificant, findings indicated that the greatest gain was in the zero drill group. The next largest gain was in the ten practice group and smallest gain was in the twenty-five practice group.

Scores were then checked for significance from pre test to post test. Only one drill group showed a significant gain from pre test to post test before adjusting the post test scores. That was the ten drill group. The F ratio was significant at the .05 level. The relative stability of the variances in the ten drill group on both pre and post tests may explain the significance of this gain score.

Conversely, the relative instability of the variances of the twenty-five and zero drill groups tends to point out the nonsignificance of their gain scores. The zero drill group showed greater gain from pre to post test but the difference in variance was sufficient to preclude significance in that group's gain score. The twenty-five drill group was also found to be nonsignificant in its pre to post gain score.

Discussion

A possible explanation for these nonsignificant findings was the size of the sample. Since all assumptions required by the statistical test administered were met, the sample size could account for the nonsignificance, but until a similar study with a larger sample is done, the inference to be drawn from this study is that the number of drill items in this arithmetic lesson had little, if anything, to do with subsequent achievement. Stephens also comments on the seeming inconsistency. "One of the psychological phenomenon to be explained is the remarkable constancy of educational results in the face of widely differing deliberate approaches."[1] Stephens calls this "Relative Constancy" and it pertains to overall learning regardless of the conditions or circumstances produced by administrative manipulation.

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[1] J. M. Stephens, The Process of Schooling: A Psychological Examination (New York: Holt, Rinehart and Winston, Inc., 1967), p. 9.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

The study was designed to determine whether a significant difference or relationship existed in the achievement of arithmetic skills with varying amounts of practice in selected Title I schools.

A review of the related literature and research indicated that there was general agreement regarding the value of practice. That is, that practice in and of itself was necessary to set or perfect the skill to be learned. The area of disagreement was in the amount of practice. The disagreement, basically, revolved around two basic theories of learning (S-R Bond and Gestalt-Field) and how they regarded the importance and amount of drill or practice.

This study investigated the effects of amounts of practice on the gains in achievement test scores on arithmetic skills. The hypothesis of the study was that there was no significant differences in achievement test scores due to various practice amounts.

Data necessary for the implementation of this study was gathered from three selected Title I schools in the Oklahoma City Public School System. The Oklahoma City Public

School System approved this proposed study prior to sample selection and testing.

The data were analyzed through the use of an analysis of co-variance test with the major objective being to test the hypothesis of no difference in achievement test scores due to varying practice amounts. The small sample used (twelve) may have been biased in favor of a larger F ratio thereby requiring a larger measure of significance than would otherwise be needed. Had the study used the population size as an N, significance would have been more easily attained.

Contamination of the results may have resulted from several influences, mostly of teacher derivation. The ability and willingness to follow directions to the letter, the truthfulness of teachers in administering the tests, the sincerity of teachers and their belief in the usefulness of this study could account for certain amounts of contamination of the results. Other factors that may have contributed to the contamination are the amount covered in the basic text and the number of concepts presented. These were not judged to be significant however, due to the small variation in pages and concepts presented.

Conclusions

The following conclusion was drawn from the findings of this study. The amount of drill used in arithmetic instruction with elementary children from selected Title I schools makes no significant difference when used as indicated by this study. The fewer practice amounts indicated greater gain scores than larger practice amounts, but this was not significant and the conclusion derived was that the amount of practice or drill did not produce significant differences in achievement. This conclusion may tend to improve mathematics instruction by helping teachers to use available time in more constructive and beneficial ways. Prolonged drill as a matter of course or fact was not supported by this study. The validity of the instrument was sufficient as was the reliability.

Recommendations

The present study dealt primarily with the amount of practice in arithmetic by elementary school children from Title I schools. The findings of this study suggest the following recommendations for further study.

1. It should be determined if there is any relation between arithmetic practice amounts and practice amounts in other academic areas.

2. Further studies may help to determine if environmental factors, such as high transient areas, play significant roles in various drill amounts.

3. It should be determined if the concept of readiness has a significant impact on various amounts of drill.

4. It should be determined if the sample size was of sufficient bias to significantly alter the study findings.

5. Finally, Title I and non Title I schools should be compared in other areas for differences that may explain the gaps existing in their norm scores.

This chapter has summarized the conclusions and recommendations of the present study. It should conclude on a positive and promising note. By suggesting the better utilization of the teacher's time and thusly improving the presentation of the teacher, it may well be that the trend toward instructional improvement will benefit the child so that the goal of teaching will become more meaningful and challenging.

BIBLIOGRAPHY

Books

Ausbel, Donald P. Educational Psychology: A Cognitive View. New York: Holt, Rinehart and Winston, 1968.

Baldwin, Alfred L. Theories of Child Development. New York: John Wiley and Sons, Inc., 1968.

Banks, J. Huston. Learning and Teaching Arithmetic. Boston: Allyn and Bacon, 1959.

Beauchamp, George A. Basic Dimensions of Elementary Methods. Boston: Allyn and Bacon, 1959.

Bigge, Morris L. Learning Theories for Teachers. New York: Harper and Row, 1964.

Bigge, Morris L. and Hunt, Marice P. Psychological Foundations of Education. New York: Harper and Row, 1962.

Bloom, Benjamin S. Stability and Change in Human Characteristics. New York: John Wiley and Sons, 1964.

Bruner, Jerome S. The Process of Education. New York: Random House, 1960.

Campbell, Donald T. and Stanley, Julian C. Handbook of Research on Teaching. Edited by N. L. Gage. Chicago: Rand-McNally and Company, 1963.

Carter, V. Good, ed. Dictionary of Education. New York: McGraw-Hill Book Co., Inc., 1959.

Crow, Lester D., and Crow, Alice. Readings in Human Learning. New York: David McKay Company, Inc., 1963.

Durost, Walter N., ed. Metropolitan Achievement Tests. New York: Harcourt, Brace and World, Inc., 1959.

Fleming, Robert S., ed. Curriculum for Today's Boys and Girls. Columbus, Ohio: Charles E. Merrill Books, Inc., 1963.

Ferguson, George A. Statistical Analysis in Psychology and Education. New York: McGraw-Hill Book Company, 1966.

Frymier, Jack. "Authoritarianism and the Phenomena of Rebellion." Curriculum Decisions: Social Realities. A.S.C.D. Yearbook, Washington, D.C., 1966.

Gage, N. L., ed. Handbook of Research on Teaching. Chicago: Rand-McNally and Company, 1963.

Glaser, Robert G. Encyclopedia of Educational Research. Vol. I, Holt, Rinehart, and Winston, Inc., 1966.

Havighurst, Robert J., ed. Metropolitanism, It's Challenge to Education. Sixty-seventh Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, Part I, 1968.

Henry, Nelson B., ed. Psychology of Learning. Forty-First Yearbook of National Society of the Study of Education. Chicago: University of Chicago Press, Part II, 1942.

__________. Human Development and Education. New York: John Wiley and Sons, 1953.

Hilgard, Ernest R. Theories of Learning and Instruction. Sixty-Third Yearbook of the National Society of the Study of Education. Chicago: University of Chicago Press, Part I, 1964.

Hill, Winfred F. Learning: A Survey of Psychological Interpretations. San Francisco: Chandler Publishing Co., 1963.

Holt, John. How Children Learn. New York: Pitman Publishing Co., 1967.

Lorenz, Konrad. On Agression. New York: Harcourt, Brace, and World, Inc., 1966.

Macdonald, James B., and Leeper, Robert R., eds. Theories of Instruction. Washington, D.C.: A.S.C.D. Yearbook, 1965.

Modill, Bair, and Richard G. Woodward. Team Teaching in Action. Boston: Houghton Mifflin Co., 1964.

Mowrer, O. Hobart. Learning Theory and Behavior. New York: John Wiley and Sons, Inc., 1960.

__________. Learning Theory and Personality Dynamics: Selected Papers. New York: Robald Press Co., 1950.

McGuin, F. J. Experimental Psychology: A Methodological Approach. New Jersey: Prentice-Hall, Inc., 1960.

Piaget, Jean. The Psychology of Intelligence. London: Routledge, and Kegan Paul, Limited, 1964.

Ryans, David G. "A Model of Instruction Based on Information Systems Concepts." Theories of Instruction. A.S.C.D. Yearbook. Washington, D.C., 1965.

Stephens, J. M. The Process of Schooling: A Psychological Examination. New York: Holt, Rinehart, and Winston, 1967.

Stroud, J. B. "The Role of Practice in Learning." The Psychology of Learning. Forty-First Yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, Part II, 1942.

Taba, Hilda. Curriculum Development: Theory and Practice. New York: Harcourt, Brace, and World, Inc., 1968.

Thorndike, E. L. Human Learning. New York: Appleton, Century, 1931.

Travers, Robert M. W. Essentials of Learning: An Overview for Students of Education. New York: The Macmillan Co., 1963.

Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill Book Co., 1962.

Periodicals

Ammons, Robert B. "Effects of Knowledge of Performance: A Survey and Tentative Theoretical Formulation." Journal of General Psychology, Vol. 54, (279-299), 1956.

Brameld, Theodore. "A Cross-Cutting Approach to the Curriculum: The Moving Wheel." Phi Delta Kappan, (346-348), Mar. 1970.

Engler, David. "Instruction Technology and the Curriculum." Phi Delta Kappan, March, 1970.

Estes, W. K., Hopkins, B. L., and Crothers, E. J. "All or None and Conservation Effects in the Learning and Retention of Paired Associates." Journal of Experimental Psychology, (329-339), December, 1960.

Gagne, Robert M.; Maykor, J. R.; Garstens, H. L.; and Paradise, N. E. "Factors in Acquiring Knowledge of a Mathematical Task." Psychological Monographs, (Whole No. 526), Nov. 7, 1962.

Gagne, Robert M. "Some New Views of Learning and Instruction." Phi Delta Kappan, pp. 469-472, May, 1970.

Kimble, Gregory A., and Shatel, Robert B. "The Relationship between Two Kinds of Inhibition and the Amount of Practice." Journal of Experimental Psychology, Vol. 44, pp. 355-359, 1952.

Pines, Maya. "How and What to Teach the Very Young Child." National Education Association Journal, p. 44, Feb., 1968.

Rock, I. "The Role of Repetition in Associative Learning." American Journal of Psychology, pp. 186-193, June, 1957.

Reynolds, J. H., and Glaser, R. "Effects of Repetition and Spaced Review upon Retention of a Complex Learning Task." Journal of Education Psychology, pp. 297-308, Oct., 1964.

Unpublished Manuscripts

Gibson, J. R. "Transfer Effects of Practice Variety in Principle Learning." Unpublished Ph.D. dissertation, University of California, 1964.

Wiegand, V. K. "A Study of Subordinate Skills in Science Problem Solving." Unpublished Ph.D. dissertation, University of California, 1969.